

**STATE OF PLANT GENETIC RESOURCES
FOR FOOD AND AGRICULTURE
in the Republic of Palau**

Country Report

September, 2008

Introduction

This report is a contribution to the preparation of the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. As the Agency overseeing implementation of the regional PGR network (PAPGREN), the SPC received support from FAO to contract a consultant in Palau to prepare a report based on a reporting format from the Commission on Genetic Resources for Food and Agriculture. The Consultant, Dr. Aurora Del Rosario, is a Researcher at the Palau Community College Cooperative Research and Extension and is the national PGR focal point in Palau. She was informed of this project during the PAPGREN Meeting in Australia in August, 2008.

Surveys and meetings were held with the Bureau of Agriculture staff led by Director Fernando Sengebau, Mr. Terebkul Tellei and Mr. Leonard Basilius of the Palau Community Action Agency. Dr. Joel Miles of the Office of Environmental Response and Coordination also provided inputs to the report.

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EXECUTIVE SUMMARY

Basic information

The islands of Palau, part of the Western Caroline Islands, are in the western part of the Pacific Ocean. Palau stretches from about 2 to 8 degrees north latitude and 131 to 135 degrees east longitude. It is about 500 miles equidistant from the Philippines to the west and from Papua New Guinea to the south. It lies within a reef system that is about 80 kilometers long and about 27 kilometers wide at its widest point. Most of the reefs are barrier reefs, but some are fringing. All of the islands in the area are inside of the reef system except the island of Angaur, which lies across a deep channel off the southern tip of Babeldaob.

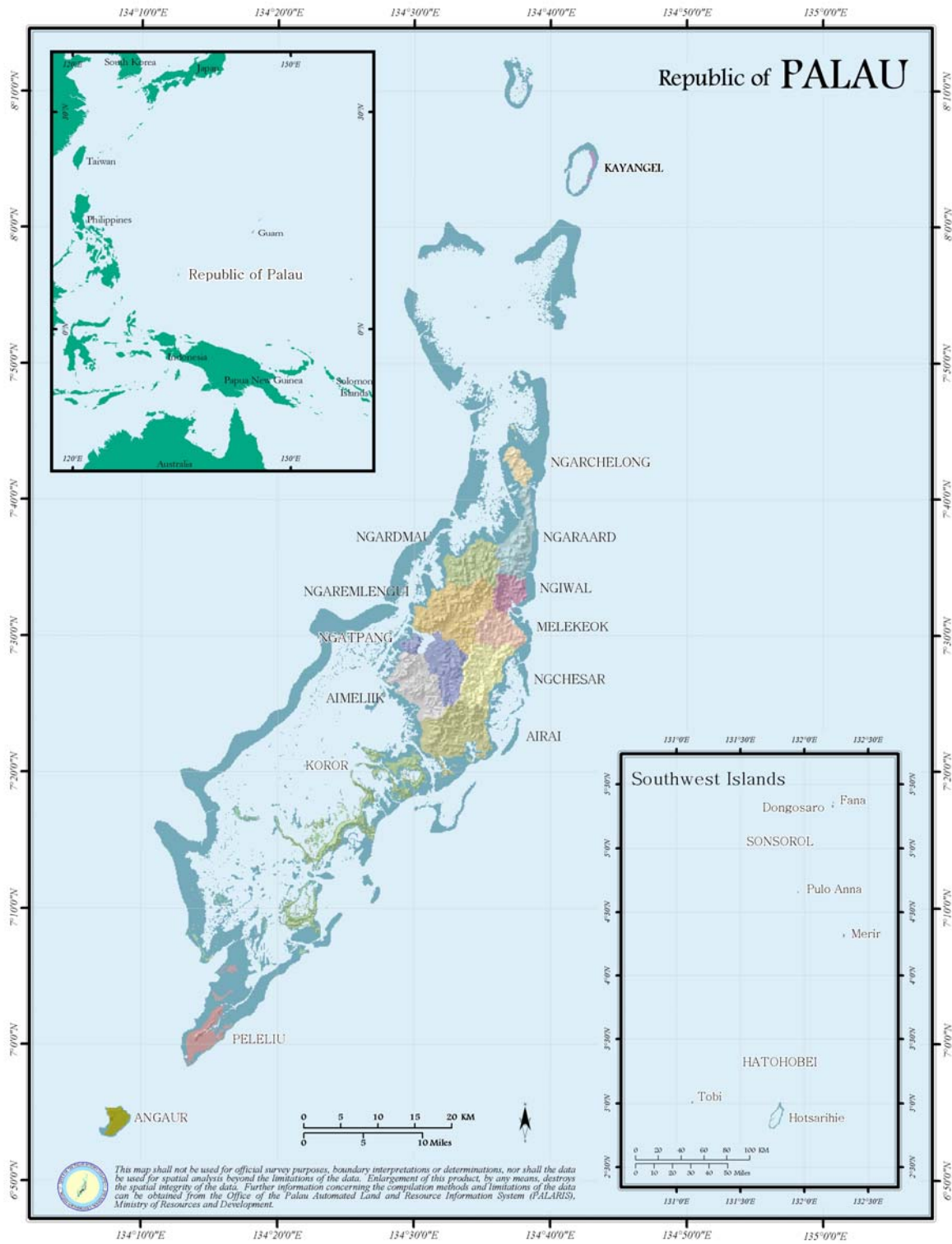
Palau covers 18.9 square miles of land area including Rock Islands. The surrounding sea area is very large, including an exclusive economic zone extending over 237,850 square miles. The capital of Palau is located in Koror with a land area of 7.1 square miles where two thirds of the population resides. Koror lies just south of Micronesia's second largest island, Babeldaob, which contains 153 square miles of undulating forests, grasslands, rivers, waterfalls, wetlands, mangroves and some of the most beautiful beaches.

Palau consists of more than 340 islands, of which 9 are inhabited. These are, from Northeast to Southwest: Kayangel, Babeldaob, Koror, Peleliu, Angaur, Sonsorol, Pulo Anna, Hatohobei, and Helen Reef. Most of the islands are volcanic in origin, and others are of raised limestone. Babeldaob is the largest island, making up 80 percent of the total land area. Babeldaob Island consists of ten states, namely, Airai, Aimeliik, Ngaremlengui, Ngerchelong, Ngchesar, Melekeok, Ngiwal, Ngaraard, Ngardmau, and Ngatpang States. Including the states in Babeldaob, there are altogether 16 states in Palau.

Palau has a maritime tropical climate. Temperature ranges from 75.8 to 90.0 F and a total of 166 inches of rainfall per year.

The Republic of Palau became an independent nation on October 1, 1994 in part with the implementation of the Compact of Free Association between Palau and the United States of America.

Total population in 1995 was 17,225 which increased to 19,907 in 2005. Over a 20 year period, average population growth rate varies from 2.1 to 2.6. Urban population increased from 71.4% in 1995 to 77.35% in 2005; while rural population decreased from 28.59% in 1995 to 22.65% in 2005. This increase in urban population means a significant increase in demand for agricultural production which has significantly affected food security and rural development. Because of this, there was an observed increase in rural poverty primarily due to urban migration which resulted in less farming manpower and therefore less food production.



State of food security and trends.

Current food production in Palau is insufficient to meet the demands for food products. Palau is still highly dependent on imported food products. This is evident in the occasional shortages of food items whenever there is bad weather or delay in arrival of ships from Guam and USA which leads to increase in food prices. Risk of food shortage as a result of low agricultural production is feared to happen in the event of climate change such as rising sea level, El Nino, drought or typhoons.

Profile of the agricultural sector

The crop sector in Palau is composed primarily of private farmers who grow the various root crops at a subsistence level for their own consumption. Average farm size of private farms in Palau is 0.25 acre or less. Recently, the Palau Farmer's Association has been organized through the initiative and assistance of the Bureau of Agriculture and the Taiwan Technical Mission, primarily to help out each other especially in the procurement and sharing of planting materials as well as marketing of their produce. Since the crops grown are mostly vegetatively propagated, planting materials, are shared or sold among and between farmers. For vegetable seeds, they are mostly imported by local retailers from the US, Taiwan or the Philippines.

Traditional agriculture in Palau has included agroforestry systems and multistory plantings of trees and root crops. Importantly, The Bureau of Agriculture has been promoting agroforestry systems which are estimated to cover 2,741 acres or 2.7 percent of the total land areas of Palau). Cultivated land without tree cover, or interspersed with some secondary vegetation is estimated to cover 1,006 acres, or one percent of the nation's land area, which includes urban cropland. Traditional crops in Palau have included species such as true taro, giant swamp taro, cassava, sweet potato, yam, banana, papaya, coconut, betel nut, and breadfruit. More recently beans, eggplant, cucumber, squash, radish, bittermelon, cabbage and watermelon have been introduced to Palauan agriculture.

At present, agriculture does not constitute a large portion of the commercial market economy. While the value of agricultural production has increased modestly over the past decade, it has declined significantly relative to the overall economy. The contribution of agriculture to gross domestic product (GDP) declined from 2.0 percent in 1992 to 1.3 percent in 2005. Agriculture in Palau is mainly for subsistence and customary purposes, although sales of products such as vegetables, root crops, fruits and betel nuts are common. Farm labor is provided by women with the most commonly produced commodities being taro, sweet potato, cassava and some fruits. There is an element of extended dualism with some women employing foreign labor to assist in the production of taro which is an important crop culturally and economically, as well as for subsistence purposes. Some foreign laborers are employed also by Palauan owners of commercial farming operations.

Recent trends in plant production

Crop production in Palau is primarily for subsistence domestic consumption and for customary purposes. Excess production is brought to the market. However, with the current cash oriented economy prevailing on the island, semi-commercial type of farming has been practiced, which rely primarily on imported foreign labor.

There is no significant change in the types and diversity of food products. However, there has been a changing trend in the increased consumption of food products which could be attributed to increase in population, the promotion on the use of local, nutritious food, the increase in demand for local produce by the hotels and restaurants, and the dramatic increase in price of imported food items.

CHAPTER 1 : The State of Diversity

The main values of plant genetic resources

Root crops are the major staple food in Palau which include primarily taro (*Colocasia esculenta*), giant swamp taro (*Cyrtosperma chamissionis*), cassava (*Manihot esculenta*) and sweet potato (*Ipomea batatas*). In addition, bananas and coconut comprise an important component of the Palauan diet. The root crops are vital to the food security of the people in Palau as well as for customary purposes. Production of these root crops is principally at the subsistence level which is now gradually shifting to the semi-commercial nature. Excess production for family consumption and customs is brought to the market for income generation. There are also other tropical crops such as sugarcane, papaya, soursop, guava, starfruit, and tropical almonds. Being quite a small country, these observations in the utilization of root crops are for the entire country.

Diversity within and between crops

Inventory and survey of these crops reveal extensive diversity of the major crops. There are 78 varieties of taro, (*Colocasia esculenta*) 22 varieties of giant swamp taro (*Cyrtosperma chamissionis*), 30 varieties of cassava (*Manihot esculenta*) and 17 varieties of sweet potato (*Ipomea batatas*). The diversity of landraces and farmer's varieties of these root crops has remained the same for the past decade.

Survey of and inventory of minor crops, underutilized species, and wild food plants have not been undertaken. However, there has been a noted increase in diversity of modern varieties especially of the vegetable crops whose cultivation is being promoted to increase local food production and reduce the nation's dependence on imported food.

Factors influencing the state of plant genetic resources in Palau

Genetic erosion of plant genetic resources of the different root crops are occurring primarily due to urbanization and negative attitude towards agriculture and farming. Other factors include environmental effects such as recurrent drought, and climate change and pests and diseases.

Future needs and priorities

An understanding of the state of diversity of plant genetic resources for food and agriculture (PGRFA) is important for economic, cultural and ecological values in Palau but the areas have not been adequately surveyed and inventoried. Some constraints to the surveying and inventorying of PGRFA are no established national priorities, insufficient financial support, staff and skills. Concurrently, monitoring of genetic erosion is not a high priority in Palau, coupled by lack of skilled personnel, lack of appropriate technology and lack of financial resources. Thus, provision for all these constraints would set the mechanisms for monitoring genetic erosion in Palau.

Chapter 2 : The State of *In Situ* Management

Inventories and surveys – Assessments and priorities

In 1998, the Palau Community College Cooperative Research and Extension (PCC-CRE) Land Grant Program has initiated the surveying and inventorying the root crops (taro, cassava and sweet potato) genetic resources which are the staple food in Palau. This continued until 2002. However, surveying of wild plants for food has not been done. This is not a current priority in Palau agriculture. Inventories and surveys of PGR and wild plants would need financial resources and training of adequate staff primarily in the Bureau of Agriculture.

On-farm management and improvement of PGRFA

Traditionally, farmers in Palau plant different varieties of the taro, cassava and sweet potato in their farm. This is a way of maintaining crop diversity and assuring the conservation of traditional varieties *in situ*. Some of the incentives adopted to promote on-farm management of root crops are extension services to farmers in terms of provision of planting materials and technical advice, as well as economic incentives to farmers. Recently, the Palau Farmer's Association has been organized primarily to promote and ensure adequate root and fruit crop production and marketing for self sufficiency to reduce reliance on imported food items. There is no current on-farm participatory plant breeding programs in Palau. Local or small scale seed production in Palau is for their own use and is assisted by technical support of extension agents of the Bureau of Agriculture. In addition, farmers have access to a wide range of planting materials provided by the Bureau of Agriculture, PCC-CRE and the Taiwan Technical Mission.

Also, processing and marketing of traditional and underutilized food crops into value-added products is being actively promoted.

Restoring agricultural systems after disasters

The *ex situ* collection of root crops germplasm at the PCC Research and Development station which serves as a national repository of the genetic resources in Palau serves as a valuable resource to replace lost PGRFA in the event of disasters such as drought and salt water intrusion.

***In situ* conservation of wild crop relatives and wild plants for food production**

There are no current activities or policies on *in situ* conservation of wild crops although they are usually considered in environmental impact assessments.

State of the Art

Currently, *in situ* management of plant genetic resources is carried out as a farmer's initiative in continually planting the traditional varieties and landraces that they favor for their own personal needs. These traditional varieties have to be continuously planted in order to maintain their genetic integrity. However, migration of the younger sector of the population to the urban sector and thus abandonment of farming activities has led to some loss on the amount of genetic material especially of the vegetatively propagated root crops. On-farm management and improvement of PGRFA is not a national priority. In addition, among the major limitations to on farm management and improvement of PGRFA include inadequate incentives provided to farmer, insufficient planting material, staff, skills and training, and financial support.

Chapter 3: The State of *Ex-Situ* Management

Sustaining and expanding *ex situ* collections

Since taro, cassava, and sweet potato are vegetatively propagated, *ex situ* collections are continuously being maintained in field gene banks at the PCC Research and Development Station. Collection of banana and citrus are being maintained in field genebanks at OISCA, Taiwan Technical Mission and Bureau of Agriculture (Table 1). Some of the biggest constraints to sustaining these collections are lack of funding, insufficient staff, lack of training and occurrence of pests and diseases. In recent years, there have been no collecting missions for major and minor crops, underutilized species, wild plants and wild relatives for food and agriculture.

Table 1 . Ex situ holdings of traditional cultivars / landraces by different stakeholders in Palau

Stakeholder	Species	Crop	No. of Accessions
Palau Community College	<i>Colocasia esculenta</i>	Taro	78
Palau Community College	<i>Manihot esculenta</i>	Cassava	30
Palau Community College	<i>Ipomea batatas</i>	Sweet potato	17
Organization for Industrial, Spiritual and Cultural Advancement	Musa spp.	Banana	12
Taiwan Technical Mission	<i>Citrus</i> spp.	Orange/Lemon	5
Bureau of Agriculture	<i>Citrus</i> spp.	Orange/Lemon	4

Planned and targeted collecting

To increase our *ex situ* collections, regular visits to farms are being conducted in the hope of acquiring more of the traditional varieties that may still be in farmer's field. Also, there is currently an effort to collect and establish an *ex situ* collection of banana in Palau.

Assessment of major *ex situ* needs

Ex situ collections in Palau can be enhanced by sharing facilities and resources through regional and international collaboration. At present, eleven varieties of taro from Palau are duplicated in the *in vitro* taro germplasm collection of the Center for Pacific Crops and Trees (CePaCT) at the Secretariat of the Pacific Community (SPC) in Suva, Fiji (Tuia, 2008 Personal communication). From the government side, there should be management actions to improve the state of *ex situ* management of plant genetic resources by assigning regular staff and allotting regular budget for the care and management of these collections.

State of the art

In vitro conservation of 30 varieties of the taro germplasm collection is currently being done at the PCC Research and Development Station as a back up strategy to the *ex situ* collection of root crops at PCC-CRE. The use of this technology could be further expanded to other vegetatively propagated crops, such as cassava, sweet potato and banana, which require financial support, adequate facilities and training of personnel and staff.

Chapter 4 : The State of Use

Distribution of plant genetic resources

Genetic resources of Palauan taro have been extensively used in the search for taro leaf blight resistance characteristics. Taro collecting mission in Micronesia including Palau was done in the 1980's through an Agricultural Development in the American Pacific (ADAP) Project to identify varieties resistant to taro leaf blight which was a major devastating disease in the Pacific. Several varieties of taro collected from Palau showed high level of resistance to this disease. These disease-resistant taro varieties were used in the taro breeding programs at the University of Hawaii and also in Samoa. It resulted in the production of leaf blight-resistant hybrids which are now widely planted and has been instrumental in the rehabilitation of the taro industry in Samoa.

Utilization and enhancement of use of PGR

Moreover, Palauan taro varieties have become acceptable and are now widely planted in Samoa and Tonga, because of their high level of resistance to taro leaf blight. In Palau, improved use of plant genetic resources is hampered by lack of characterization and evaluation, insufficient capacity for plant breeding, lack of qualified personnel, funds training and facilities. At a national level, there should be a national program and policy to enhance use of plant genetic resources. Enhanced utilization of plant genetic resources is currently achieved through distribution of planting materials to local farmers and increased collaboration among researchers at regional and international organizations and agencies. Furthermore, development of processed food products from local varieties and exploring their market opportunities has enhanced utilization of these different root crops and local fruits.

Sweet potato, cassava and taro germplasm collection have only been morphological characterized. Molecular and biochemical characterization have to be employed to ascertain the diversity of these genetic resources. Due to limitations in facilities and adequate trained personnel, this characterization can be done in collaboration with regional and international agencies. Furthermore, Palau does not have any capacity for plant breeding activities. We are currently relying on the results of breeding activities in Hawaii and Samoa using Palauan taro genetic resources, bring these hybrids to Palau and evaluate their acceptability and performance under Palauan environment. Through PAPGREN, taro varieties and hybrids from Pacific and Asian countries have been requested from the taro germplasm collection of CePaCT of SPC in Suva, Fiji. In 2006, we have received 5 taro hybrids and varieties which are currently being evaluated in field trials for agronomic characteristics, disease and pest resistance and acceptability to Palauan consumers. In 2007, another 5 hybrids have been received from CePaCT but these are still being multiplied in tissue culture to obtain sufficient planting materials for field trials.

Seed supply systems and role of markets

There are no current seed production activities and capabilities in Palau. Distribution of imported vegetable seeds from the Philippines, Taiwan and the U.S. for local food production is done mainly by the private sector.

Plans to support the development of new markets for local food production are underway with the completion of the feasibility study for the establishment of a Central Market for agricultural products and by-products in Palau. However, implementation still requires legislation which is still being studied and discussed in the Palau Congress.

There are efforts to increase the utilization of local produce through processing into value-added products. Several trainings have been conducted to empower the communities in the production of value-added products derived from fruits and root crops and promote the production and marketing of “Made in Palau” products.

Crop improvement programs and food security

There is no formal-sector crop improvement program in Palau.

Chapter 5 : The State of National Programs, Training Needs and Legislation

National Programmes

Palau does not have a formal National PGRFA Program. However, activities on plant genetic resources conservation and utilization are carried out by the Palau Community College in coordination with other government and non-government agencies.

Networks

Palau is a member of the Pacific Agricultural Plant Genetic Resources Network (PAPGREN). As such some of our taro genetic resources which are currently in Samoa and were used in their breeding program are also held in the *in vitro* taro germplasm collection of the Center for Pacific Crops and Trees (CePaCT). Through the PAPGREN, we also get new taro germplasm from other Pacific and Asian countries and evaluate them for their adaptability to Palau environment (see Chapter 4).

Education and training

There is no national strategy for education and training to support the use, development and conservation of plant genetic resources. Most agriculture staff currently involved in germplasm conservation and use has not received formal training in the field. Sufficient university level training opportunities and some short course training opportunities exist

in the region, but local staff has not participated in these trainings. The main obstacle to providing required education and training needs for plant genetic resources is the insufficient formal educational background and qualification of local staff to undergo these training courses. Staff development has to be undertaken to recognize and implement the mechanisms of plant genetic resources conservation, sustainable utilization and development.

National legislation

In the past 10 years, Phytosanitary regulations have been established in Palau which are relevant to plant genetic resources. These regulations have prevented the entry of pests and diseases to major crops as well as invasive species in Palau.

In addition, Palau has acceded to the International Treaty on PGRFA, which is a legally binding international instrument. As such we need to apply provisions and obligations derived from being part of the Treaty with regard to inter alia access and exchange of germplasm.

Information systems

Palau has not developed a national information management system to support efforts to sustainably use, develop and conserve plant genetic resources. However, a catalog on morphological characterization for sweet potato and cassava varieties in Palau has been prepared and published. About 40 taro varieties have been identified and morphologically characterized. However, this information still has to be published.

Public awareness

Awareness on the roles and values of plant genetic resources is being done by exposure of farmers, school children and the general public during field visits, workshops, special events, and fairs such as the Olechotel Belau Fair, Earth Day, Agriculture Fair, World Food Day and Independence Day. The role of the print media and radio talk shows also help a lot in creating awareness on PGR of Palau. This is also an opportunity to gather information on levels of genetic diversity on farm as well as genetic erosion.

Chapter 6 : The State of Regional and International Collaboration

International networks and programs

As a member of the PAPGREN, Palau has access to the genetic materials at the CePaCT at the Secretariat of the Pacific Community (SPC) in Suva, Fiji. Several germplasm of taro, sweet potato and banana has been received from CePaCT and these are now being evaluated at the PCC Research and Development Station in Ngermeskang, Ngaremlengui.

Also, Palau is one of the countries implementing the four-year program on Development of Sustainable Agriculture in the Pacific (DSAP) sponsored by the SPC. This program has been actively promoting the adoption of sustainable agriculture practices and has eventually improved agricultural production capacity in Palau.

There is also an FAO Project on Value-Added Products for Food Crops. This five-year project provides training to communities, organizations and individuals on processing of agricultural produce into value-added products to prolong the shelf life of products for food security.

International Agreements

Palau has acceded to the Convention on Biological Diversity (CBD) in November, 1998 which is being coordinated by the Office of Environmental Response and Coordination. One of the three main goals of the CBD is the fair and equitable sharing of the benefits arising from the use of plant genetic resources. The CBD also has addressed traditional knowledge and intellectual property rights and access to genetic resources.

Recognizing the interdependence of all countries on each other on plant genetic resources for food and agriculture, Palau has just acceded to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) in July, 2008. This facilitates and allows access to the global pool of genetic resources of important food crops in the world. It also prevents recipients of these genetic resources from claiming intellectual property rights over these resources.

Chapter 7 : Access to Plant Genetic Resources and Sharing of Benefits Derived from their Use, and Farmer's Rights

Access to PGR

Palau has received some taro germplasm from SPC in 2003, they have not been properly documented and evaluated due to lack of appropriate training and expertise. Access to PGR has improved in the last 5 years. Moreover, participation in the PAPGREN has enabled us to gain access to some taro germplasm from the CePACT at SPC in Suva, Fiji. To date, 10 accessions have been received and these are currently being evaluated at the PCC Research and Development Station for acceptability, performance, yield and resistance to pests and diseases.

An unfortunate incident on access to plant genetic resources outside Palau was experienced recently in that three taro hybrids developed at the University of Hawaii using Palauan taro germplasm as parents have been patented and we could not obtain these materials for use in Palau. The furor of the local Hawaiian farmers and protest of the Palau government over this policy and action of the University regarding the limited access to these hybrids was resolved when they recently lifted the patent for these taro

hybrids. They are now part of the CePaCT taro germplasm collection and Palau will be the first to gain access to these hybrids once they have been certified free from viruses.

In compliance with the ITPGRFA, Palau abides by the Multilateral System of Access and Benefit Sharing.

Fair and Equitable Sharing of the Benefits of the use of PGR

At present, farmers are currently growing different varieties of crops who are the primary custodians of these genetic diversity. Farm produce are for family consumption so the farmers are the ones benefiting from all the PGR. Some are shared to relatives for customary purposes and extra produce are brought to the market, thus benefiting the businesses and consumers. With the use of varieties of crops with improved genetic materials, farmers are assured of high production, thus ensuring availability of agricultural produce to consumers and businesses.

Implementation of Farmer's Rights

The development and patenting of taro hybrids resistant to leaf blight at the University of Hawaii without the acknowledgement and consent of Palauan farmers is a glaring example of violation of farmer's rights. Although there are no breeding programs in Palau where farmers are involved, farmers still have rights to these genetic materials since they have been growing these traditional varieties for many generations. In the future when farmers participate in the development of new products / varieties, their rights should be protected.

Palau's National Biodiversity Strategy and Action Plan (NBSAP) includes "Sharing Benefits of Genetic Resources" as one of its eight themes, and proposes a number of actions to be taken under this theme, including adoption of legislation to protect and maximize equitable sharing of benefits arising from the use of Palau's genetic resources.

However, despite the NBSAP proposed actions and workshop recommendations, Palau has not developed a national legal framework to regulate the access to and use of genetic resources. The reasons for this are many and complex, but the greatest obstacle is the lack of technical and legal expertise to develop such a legal framework.

The Palau Copyright Law also gives protection to discoveries, inventions and materials produced in Palau.

With Palau now being a party of the ITPGRFA this assures the farmer's rights to equitable sharing of benefits arising from the utilization of PGRFA and the right to participate in making national decisions on the conservation and sustainable use of PGRFA.

Chapter 8 : The Contribution of PGRFA Management to Food Security and Sustainable Development

PGRFA management is vital to provide support to countries threatened by food shortage so they can ask help from regional and international agencies as sources of genetic materials to ensure food security in the event of climate change and global crisis.

The establishment of the *ex situ* collection of the root crops in Palau is a major step towards the conservation of the PGRFA in Palau. This has raised the level of awareness of the diversity of PGR which has to be protected to ensure food security in the country. It has also led to a conscious effort to ensure the conservation and sustainable use of these valuable genetic resources.